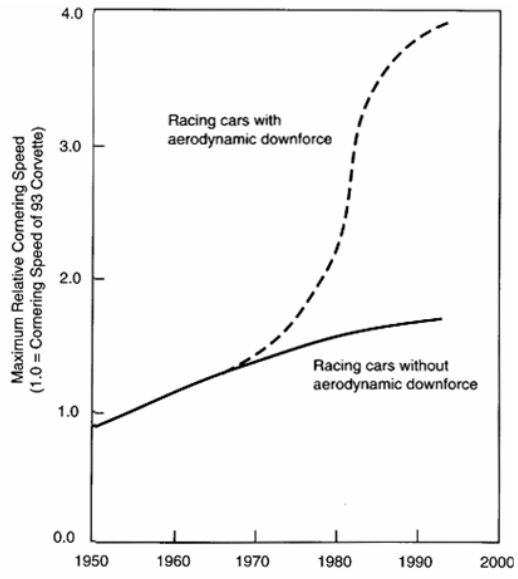
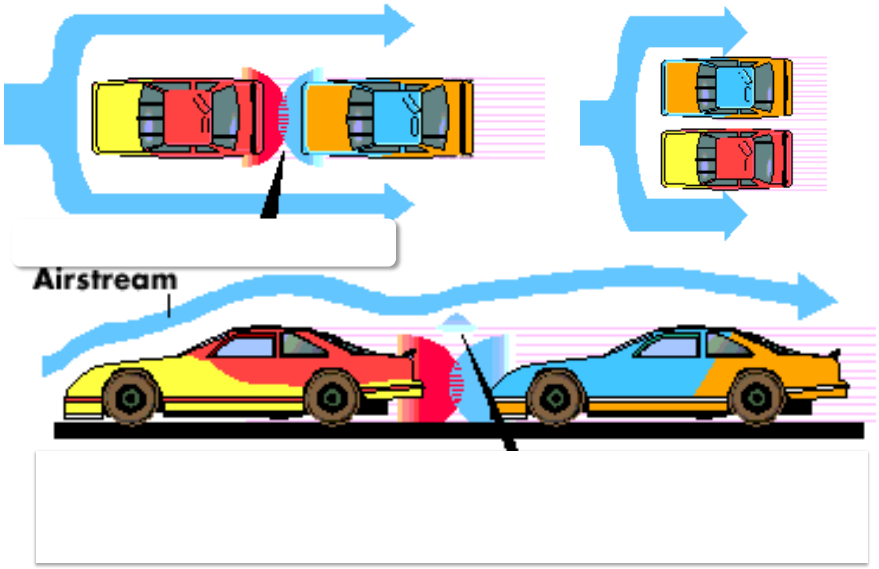
Why Does Aerodynamics Matter?

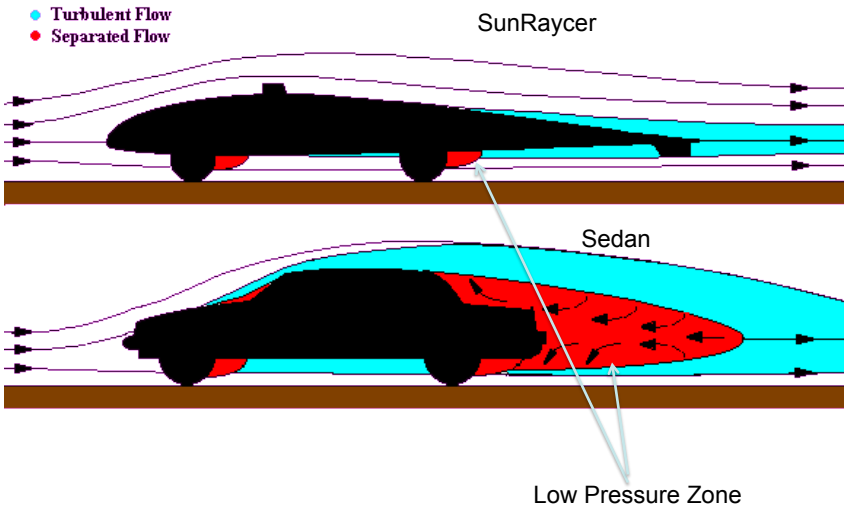


Source: Race Car Aerodynamics, J. Katz, 1995

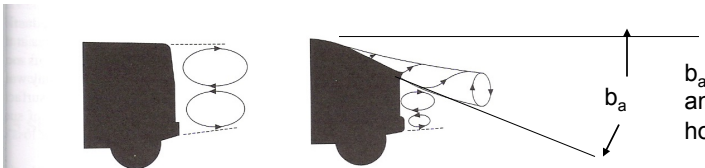
NASCAR Drafting Technique



Aerodynamic Effects



Rear End Effects



b_a = backlight angle (from horizontal)

Figure 5.4(a) 'Squareback' large scale flow separation. (b) 'Hatchback/Fastback' vortex gener

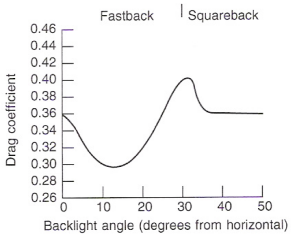
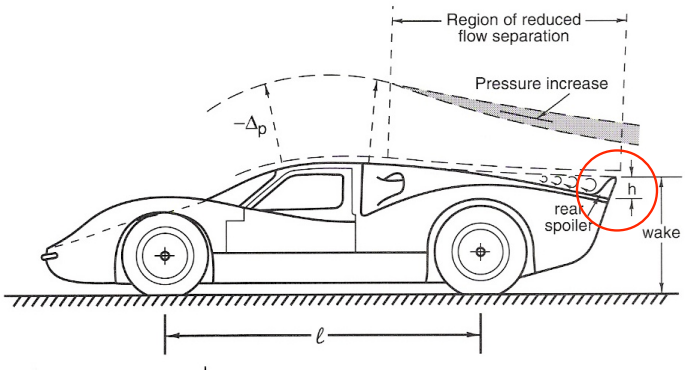
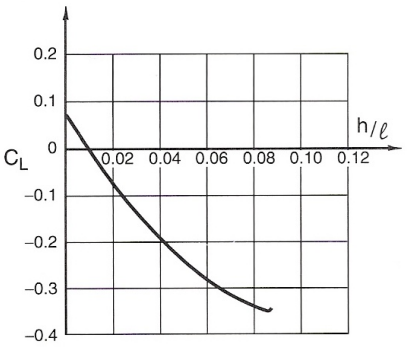


Figure 5.5 The influence of backlight angle on drag coefficient

Spoiler



Spoiler effect on lift



Effect of rear spoiler on typical G.T. racing car.

Figure 15.1 *Rear spoiler on G.T. car (Ref. 143).*

C_L is the lift coefficient, normalized by the frontal area.

Adjustable down force

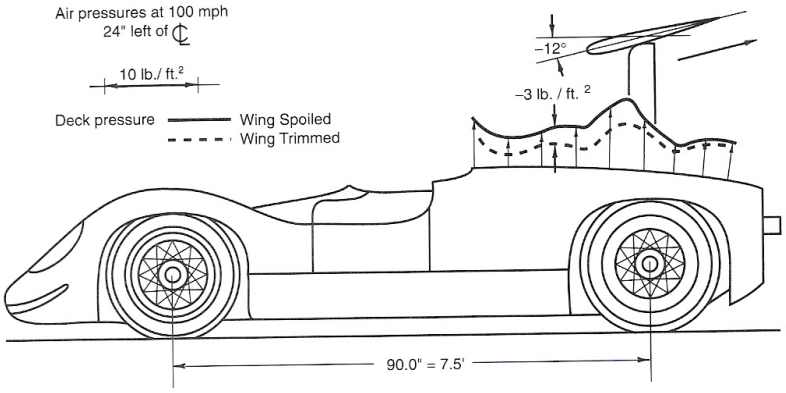
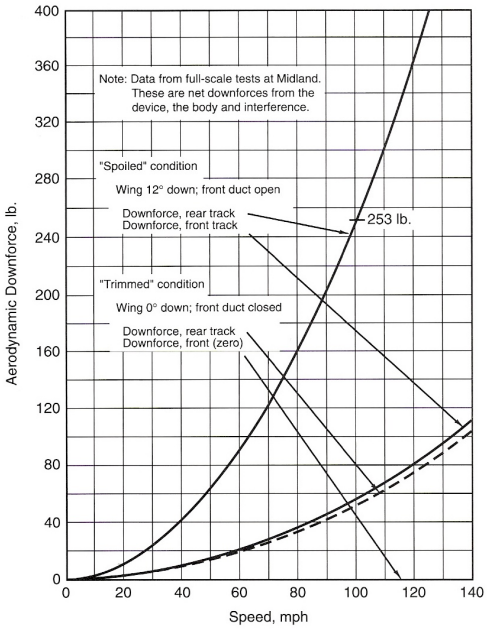


Figure 15.11 *G.S. 2G full-scale pressure measurements, unpublished.*



Adjustable down force

wing aero down force: 266 lb down

wing drag: 60 lb down

pressure on deck: 73 lb up

NET with 12º spoiler: 253 lb down

Ground Effects

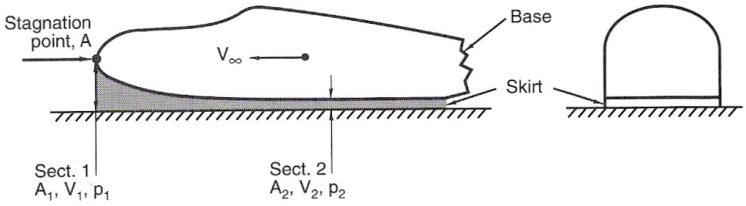


Figure 15.30 *Simple ground-effects vehicle.*

Bernoulli's equation says

$$p_\infty + \frac{1}{2}\rho V_\infty^2 = p_2 + \frac{1}{2}\rho V_2^2$$

Optimal aerodynamic shape

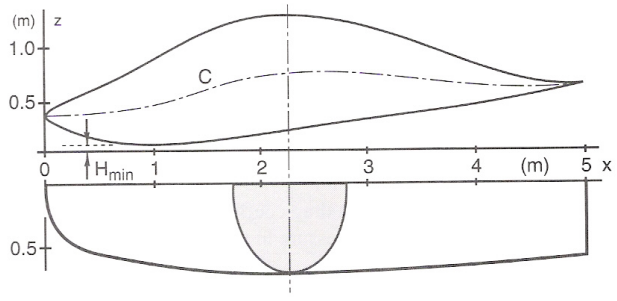


Figure 15.48 *Morelli basic body shape (Ref. 97).*

C_D approximately 0.05.

A. Morelli, Turin Technical University

Ground Effects

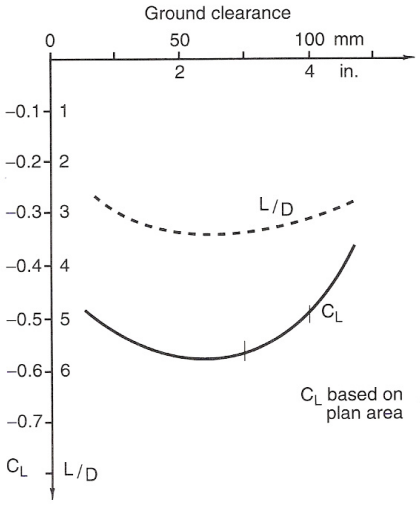


Figure 15.29 *Lotus ground-effects wind tunnel results (Ref. 168).*

Homework Problem

Assume the drag coefficient of a 3000 pound automobile with a frontal area of 20 ft^2 is 0.38 but increases to 0.42 with the windows open. Assume its air conditioner draws 2.0 horsepower. Assume calm winds.

When traveling at 65 mph, which is more efficient: i.) keeping the windows open and the air conditioner off, or ii.) closing the windows and running the air conditioner?

General Considerations

- Down force and aerodynamic drag should be properly balanced for the application
- Keep stagnation point low on front of vehicle

General Considerations

- Avoid flow separation caused by:
  - Excessive body angles
  - Too small radii (nose, radiator diffuser, etc.)
  - Sharp edge attachments (mirrors, handles)
  - Surface roughness
  - Improper internal airflow control
  - Wheel well and underbody treatment

References

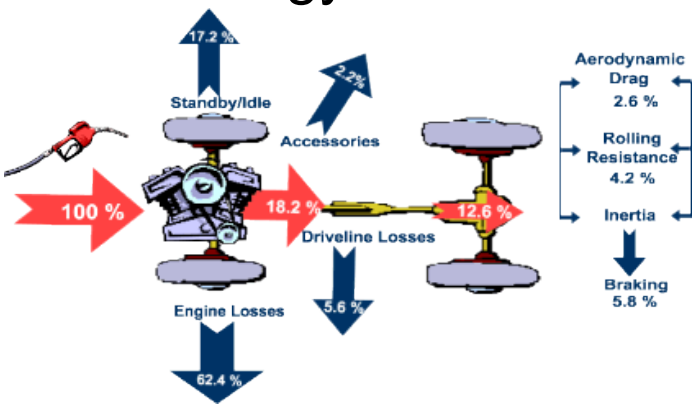
97. Morelli, Alberto, “Aerodynamic Basic Bodies Suitable for Automobile Applications”, Proc of the International Assoc for Vehicle Design, Special Pub, SP3, 1983.

140. Schenke, Franz, “The origins of Drag and Lift Reductions on Automobiles with Front and Rear Spoilers,” SAE 770389, Society of Automotive Engineers, Warrendale,PA

143. Scibor-Rylski, A.J., “Negative Lift Devices on Racing Cars,” Paper 19, Proc of the First Symposium on Road Vehicle Aerodyamics, London, 1969.

160. Van Valkenburgh, Paul, “Some Technicalities from 1988”, Road and Track, April 1989.

Energy Losses



At highway speeds, 54% of energy is spent on overcoming aerodynamic drag.

http://www.fueleconomy.gov/feg/atv.shtml

Reducing Drag

40% reduction in drag is possible using various control surface arrangements

http://www.fueleconomy.gov/feg/atv.shtml